WPAFB RADIATION SAFETY OFFICE
SHIPMENT QUALITY ASSURANCE CHECKLIST

April 2000

Date:_____ Shipper: _____ Destination: _____

Item(s) Description:_____

Radionuclide(s):_____ Activity: _____mCi (_____MBq) Gross Mass:_____kgm

Radiation Survey Results: surface:_____mrem/hr (_____ mSv) 1 meter:_____ mrem/hr (_____ mSv)

Instrument Used Mfgr:_____ Model:_____ S/N:_____ Cal Date: _____

Person Completing Checklist: _____Signature: _____

Activity Conversion Factors

1 Curie (Ci) = 0.037 Tera Bequerels (TBq)	1 TBq ≈ 27 Ci	**5.0 Ci X 0.037 TBq/Ci** = 0.185 TBq (185 GBq)
1 millicurie (mCi) = 37 Mega Becquerels (MBq)	1 MBq ≈ 0.027 mCi	**0.015 mCi X 37 MBq/mCi =** 0.555 MBq (555 kBq)
1 microcurie (μCi) = 0.037 MBq	1 MBq ≈ 27 μCi	**15 mCi X 0.037 MBq/mCi =** 0.555 MBq (555 kBq)

Exposure Conversion Factors

1 rem (rem) = 10 milliSieverts (mSv)	1 mSv = 100 mrem	**3.5 mrem / 100** = 0.035 mSv (35 μSv)
1 millirem (mrem) = 10 microSieverts (μSv)	1 μSv = 0.1 mrem	**0.2 mrem / 100** = 0.002 mSv (2 μSv)

Type A Shipping Requirements

PACKAGING

Yes No

__ __ 1. Activity less than A_1 (special form) or A_2 (normal form) quantities. [173.435]
__ __ 2. General Design Requirements for a Type A Package Used? Testing results on file? [173.412, 173.415(a)]
__ __ 3. A security seal is attached such that evidence of package has not been opened. [173.412(a)]
__ __ 4. Removable surface contamination less than 0.04 Bq/cm^2 (2.2 dpm/cm^2(alpha)) or 0.4 Bq/cm^2 (22 dpm/cm^2(beta/gamma)). [173.443]

MARKING

Yes No

__ __ 1. Proper shipping name (ex. Radioactive Material, n.o.s.). [172.301(a)]
__ __ 2. Identification number (ex. UN2982). [172.301(a)]
__ __ 3. If greater than 110 lbs (50 kgm), gross mass plainly and durably marked. (172.310(a))
__ __ 4. Package specification (DOT 7A TYPE A USA). [172.310(b)]
__ __ 5. The letters "RQ" if activity is equal to or greater than 172.101 Appendix A, Table 2. [172.324(b)]
__ __ 6. Name and address of consignee or consignor. [172.301(d)]

LABELING

Yes No

__ __ 1. Category of label applied appropriate to survey results. [172.403(b)]
__ __ 2. Two labels affixed to opposite sides (excluding bottom) and near the marked proper shipping name. [172.403(f); 172.406(a)(ii)]
__ __ 3. Label contents include radionuclide(s), activity, and T.I (dimensionless number rounded up to the next tenth, ex. 0.14 becomes 0.2). [172.403(g)]
__ __ 4. Cargo Aircraft Only label if potential of air transport. (172.402 (2)(c))

SHIPPING PAPERS

Yes No

__ __ 1. Proper shipping name, hazard class number ("7") and identification number (UN####). [172.202, 172.203]
__ __ 2. Name of radionuclide, chemical and physical form (ex: oxide, solid), and activity (units of Becquerels). [172.203(d)]
__ __ 3. Type of package (DOT 7A TYPE A). [172.202(5)(c)]
__ __ 4. Category of label affixed to package (ex. RADIOACTIVE YELLOW II). [172.203(d)(5)]
__ __ 5. Transport Index assigned to packages bearing Yellow II or Yellow III label (example T.I. = 0.1). [172.203(d)(6)]
__ __ 6. The letters "RQ" if activity is equal to or greater than 172.101 Appendix A, Table 2. [172.203(c)(2)]
__ __ 7. Shipper's certification, unless shipper transports (This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation). [172.204]
__ __ 8. Emergency response telephone number. [172.201(4)(d)]

TYPE A QUANTITIES FOR SELECTED RADIONUCLIDES
(49 CFR 173.435)

Radio-Nuclide	*A_1 Quantities (Special Form)*		*A_2 Quantities (Normal Form)*		*Reportable Quantities*	
	(TBq)	*(Ci)*	*(TBq)*	*(Ci)*	*(TBq)*	*(Ci)*
^{241}Am	2	54.1	0.0002	0.00541	0.00037	0.01
^{133}Ba	3	81.1	3	81.1	0.37	10
^{14}C	40	1080	2	54.1	0.37	10
^{57}Co	8	216	8	216	3.7	100
^{60}Co	0.4	10.8	0.4	10.8	0.37	10
^{137}Cs	2	54.1	0.5	13.5	0.037	1.0
^{55}Fe	40	1080	40	1080	3.7	100
^{3}H	40	1080	40	1080	3.7	100
^{123}I	6	162	6	162	0.37	10
^{125}I	20	541	2	54.1	0.00037	0.01
^{129}I	**Unlmt**	**Unlmt**	**Unlmt**	**Unlmt**	0.000037	0.001
^{131}I	3	81.1	0.5	13.5	0.00037	0.01
^{192}Ir	1	27	0.5	13.5	0.37	10
^{85}Kr	20	541	10	270	37	1000
^{63}Ni	40	1080	30	811	3.7	100
^{32}P	0.3	8.11	0.3	8.11	0.0037	0.1
^{210}Po	40	1080	0.02	0.541	0.00037	0.01
^{239}Pu	2	54.1	0.0002	0.00541	0.00037	0.01
^{226}Ra	0.3	8.11	0.02	0.541	0.0037	0.1
^{187}Re	**Unlmt**	**Unlmt**	**Unlmt**	**Unlmt**	37	1000
^{90}Sr	0.2	5.41	0.1	2.7	0.0037	0.1
^{99m}Tc	8	216	8	216	3.7	100
^{99}Tc	40	1080	0.9	24.3	0.37	10
Thorium	**Unlmt**	**Unlmt**	**Unlmt**	**Unlmt**	0.0037	0.1
Uranium	**Unlmt**	**Unlmt**	**Unlmt**	**Unlmt**	---	---

Unlmt = Unlimited
Limits are for Thorium (Natural)
Limits are for Uranium (Depleted)

KEY DEFINITIONS/POINTS

Special Form Radioactive Material (A_1)	Either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule. The piece or capsule has at least one dimension not less than 5 millimeters (0.2 inch) and satisfies the test requirements of 173.469.
Normal Form Radioactive Material (A_2)	Radioactive material which has not been demonstrated to qualify as "Special Form Radioactive Material"
Overpack	A package used to consolidate individual packages. The packages must comply with the packaging, marking and labeling requirements of 173.412, 173.415, 172.310, 172.403. The overpack must be labeled as prescribed in 172.403 and marked as prescribed in Subpart D of Part 172 and 173.25(a).
Prohibited Marking 49 CFR 172.303	A summary of the prescribed part: If you ship a Radioactive White I package, DO NOT place a Radioactive Yellow II/III label on the package or otherwise mark the package outside the prescribed requirements for the mode or transportation. Additionally, if you ship an excepted package DO NOT place a Radioactive White I or Yellow II/III label on the package or otherwise mark the package outside of the prescribed requirements listed for excepted packages.

WORKSHEET

Item Activity _____ µCi X 0.037 MBq/µCi = _____MBq

Item Activity _____ MBq X 10^{-6} TBq/MBq = _____TBq

Package Surface _____ mrem/hr X 0.01 mSv/mrem = _____ mSv/hr

Package Weight _____ lbs / 2.205 kgm/lb = _____ kgm

RADIATION LEVEL LIMITS
(49 CFR 172.403 & 173.441)

Label Category	Transport Index	Radiation Limits
White I	0 *	≤ 0.005 mSv/hr (≤ 0.5 mrem/hr)
Yellow II	≤ 1.0	≤ 0.5 mSv/hr (≤ 50 mrem/hr)
Yellow III	≤ 10	≤ 2 mSv/hr (≤ 200 mrem/hr)

* If the measured TI is not greater than 0.05, the value may be considered to be zero.

REMOVABLE EXTERNAL PACKAGE CONTAMINATION LIMITS
(Averaged over 300 cm^2)
(49 CFR 173.433)

	Bq/cm^2	µCi/cm^2	dpm/cm^2
Beta and gamma emitters and low toxicity alpha emitters	0.4	10^{-5}	22
All other alpha emitting radionuclides	0.04	10^{-6}	2.2

Swipe Evaluation (ADM-300):

$$Bq/cm^2 = \frac{cpm(net)}{0.5 \times E_c \times 60 \frac{\text{sec}}{\text{min}} \times A(cm^2)}$$

E_c = Probe Efficiency (AP-100 = 0.3 for ^{239}Pu; BP-100 = 0.3 for ^{90}Sr)
A = Area Swiped (300 cm^2)
$cpm_{(net)}$ = Background subtracted from gross count
0.5 = 2p to 4p conversion
1 Bq = 1 dps or 60 dpm

EXAMPLE:

$$\frac{Bq}{cm^2} = \frac{100\ cpm}{0.5 \text{ x } 0.3 \text{ x } 60 \frac{\text{sec}}{\text{min}} \text{ x } 300 cm^2} = \frac{100}{2700} = 0.037 \frac{Bq}{cm^2}$$

$$0.037 \frac{Bq}{cm^2} \times 60 \frac{dpm}{Bq} = 2.22 \frac{dpm}{cm^2}$$